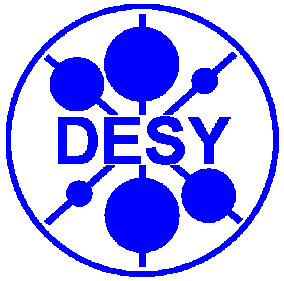

TESLA

Influence of different gas layers on the secondary electron emission coefficient

Denis Kostin, MHF/sl, DESY

derived from the talk given by Noel Hilleret, CERN - LHC/VAC.

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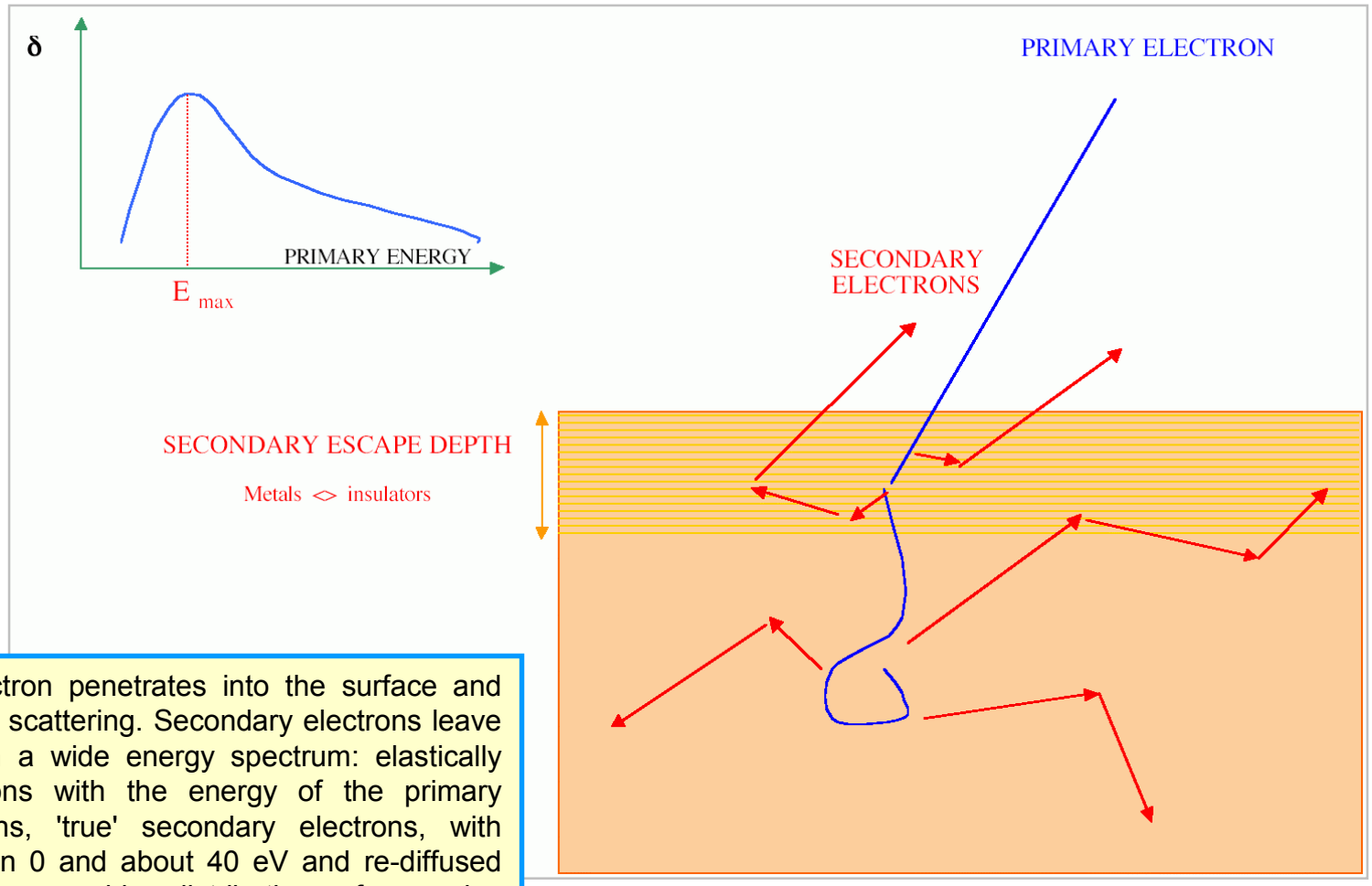
1. General Notes

- Secondary Electron Emission Coefficient is an important surface characteristic, describing general ability of material surface to emit the electrons.
- The secondary electron yield of technical metals depends strongly on the roughness of the surface and on the composition of the oxide layer, as well as on the condensed gas layers.
- During operation of RF power components a gradual 'conditioning' occurs. The effect of dosing of a surface with electrons or photons decreases the secondary electron yield to a value of δ_{max} which can be lower than one of the base material.
- The physical processes, which cause this reduction of δ_{max} can be attributed to the formation of a carbon rich layer on the top surface and/or surface oxide reduction. Carbon is known to have a low secondary electron yield.
- There is no indication that the final secondary electron yield after conditioning depends on the base material

Secondary Electron Emission

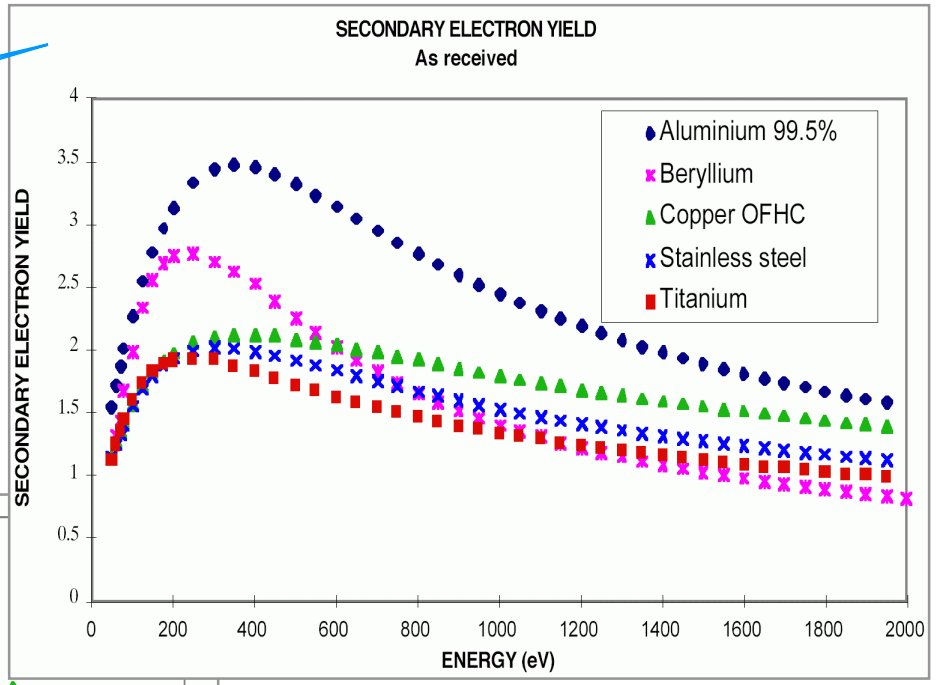


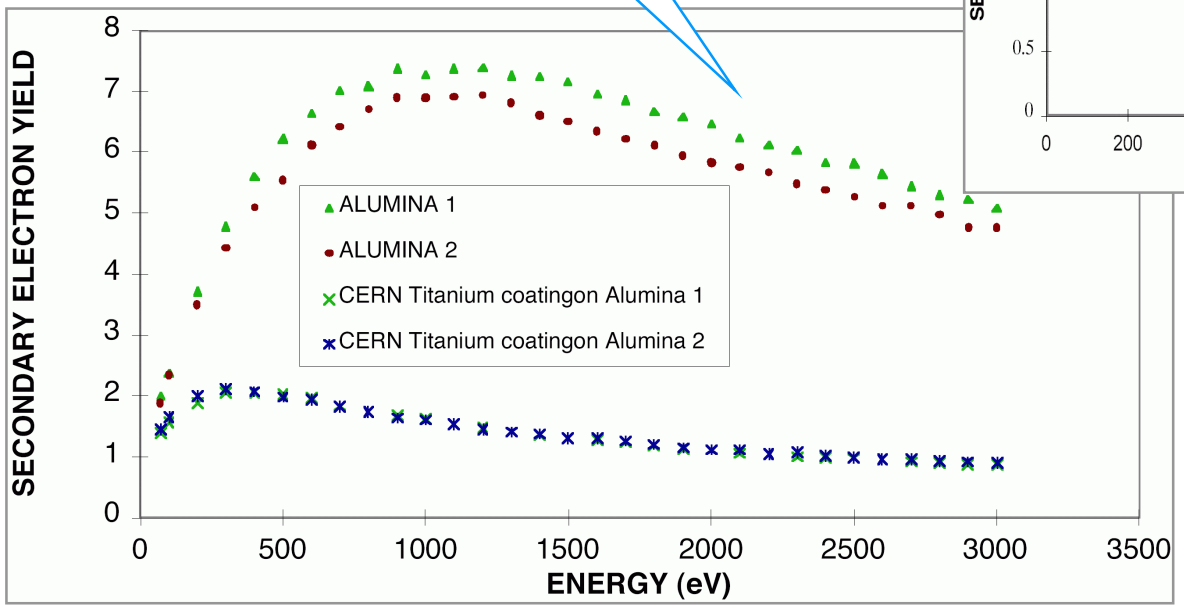
An incident electron penetrates into the surface and undergo multiple scattering. Secondary electrons leave the surface with a wide energy spectrum: elastically reflected electrons with the energy of the primary incident electrons, 'true' secondary electrons, with energies between 0 and about 40 eV and re-diffused primaries having a wide distribution of energies between the elastic peak and the true secondaries.

2.Data: Secondary Emission Coefficients

metals

ceramics (Al_2O_3)





from N. Hilleret, CERN - LHC/VAC

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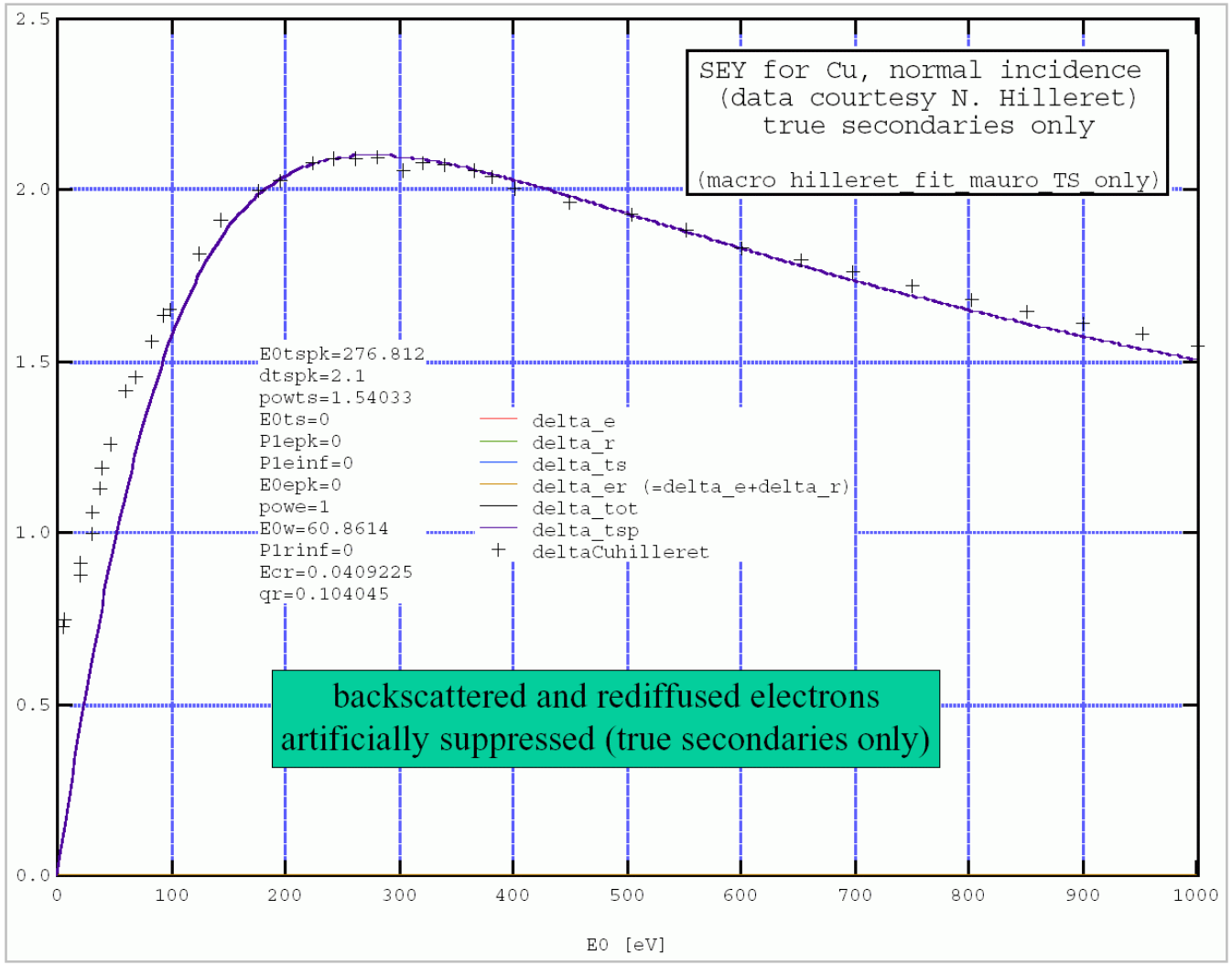
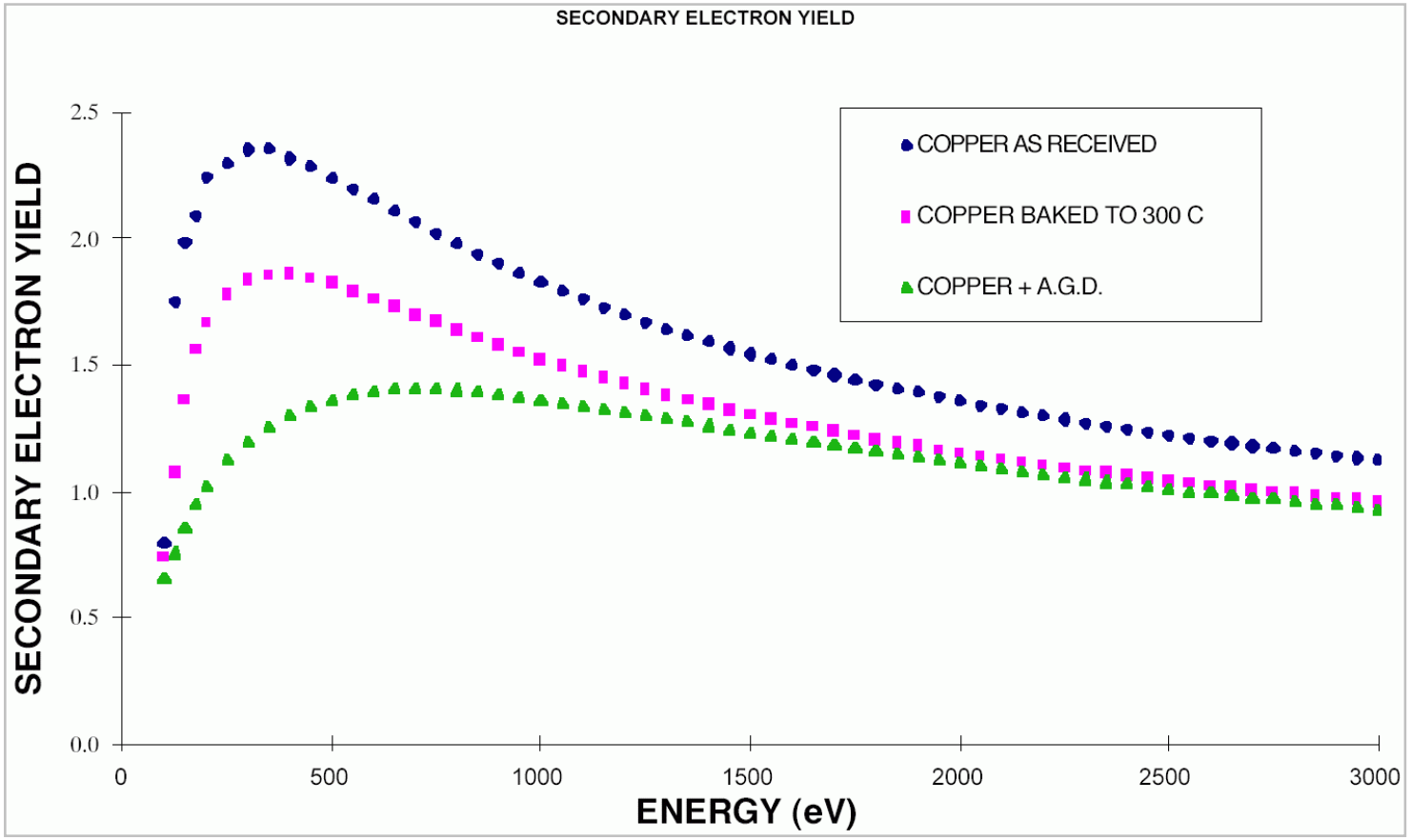
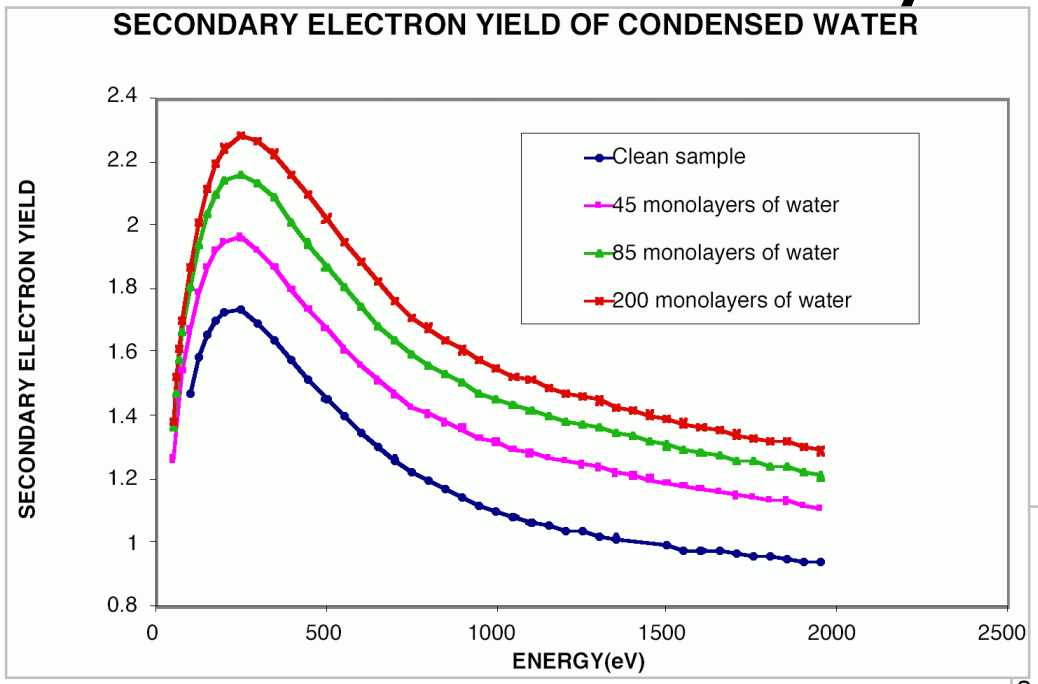
Secondary Emission Yield (1)



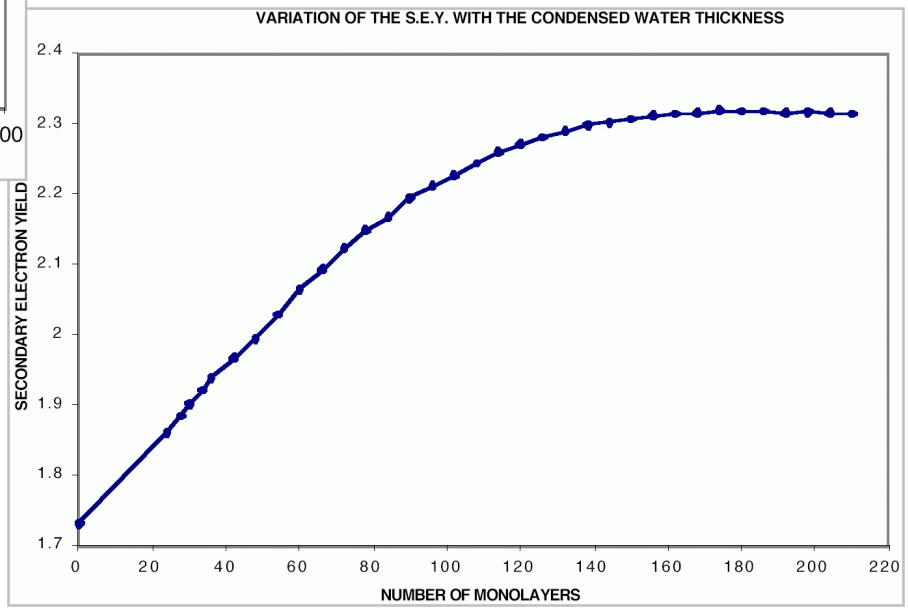
Secondary Emission Yield (2)



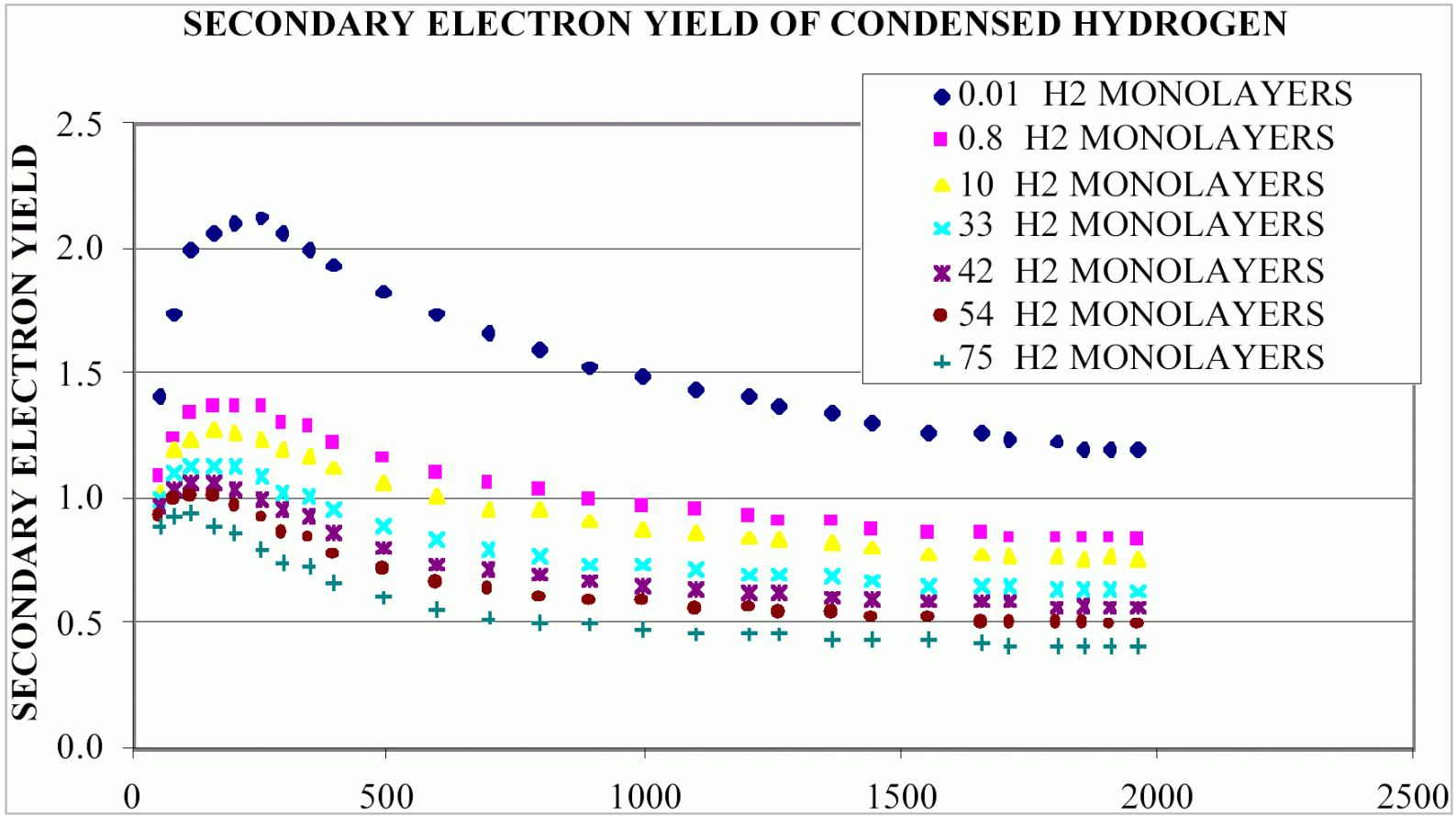
Secondary Emission Yield (3)



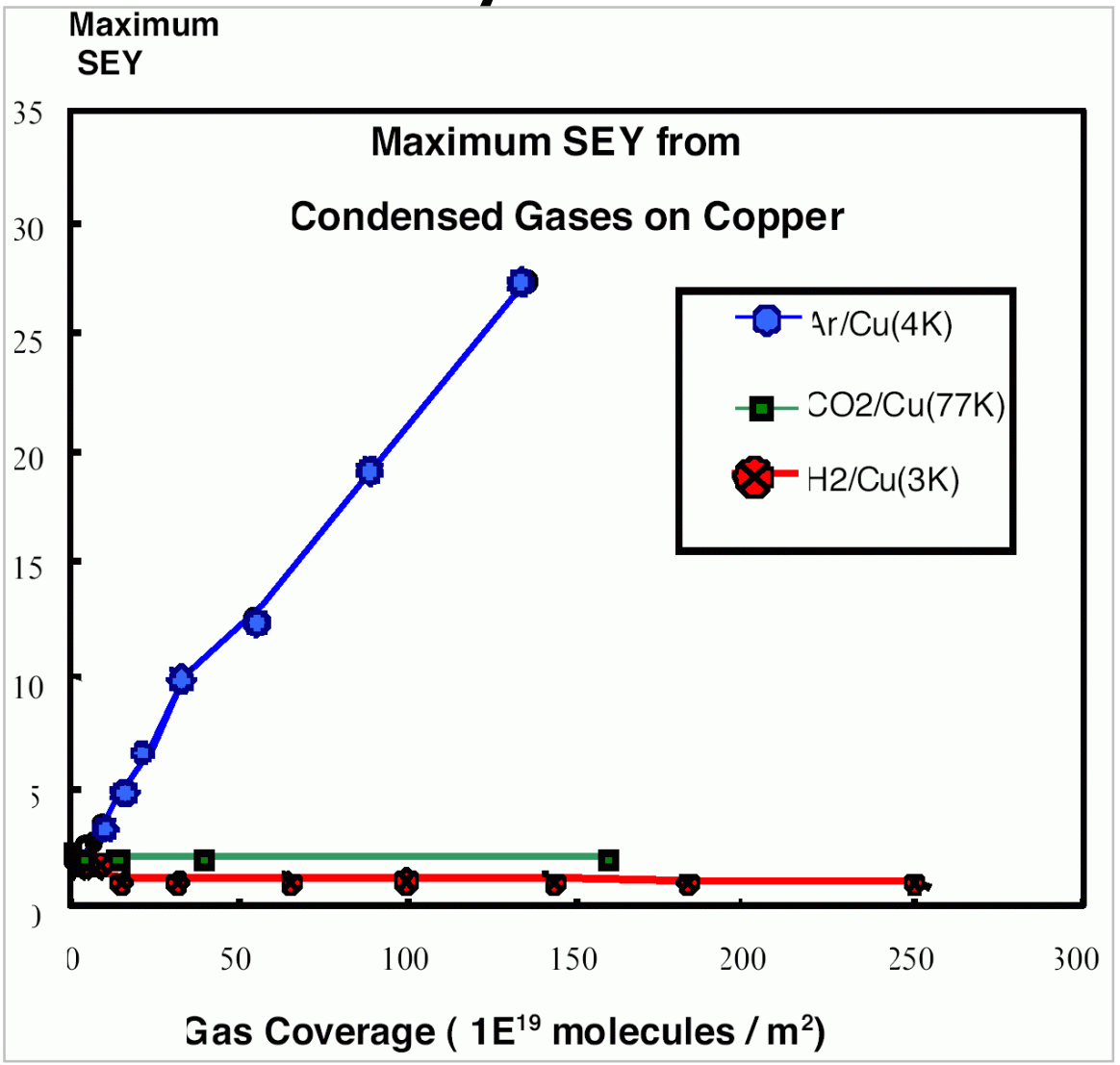
Increasing of δ_{max} with H_2O layer thickness



Secondary Emission Yield (4)



Secondary Emission Yield (5)



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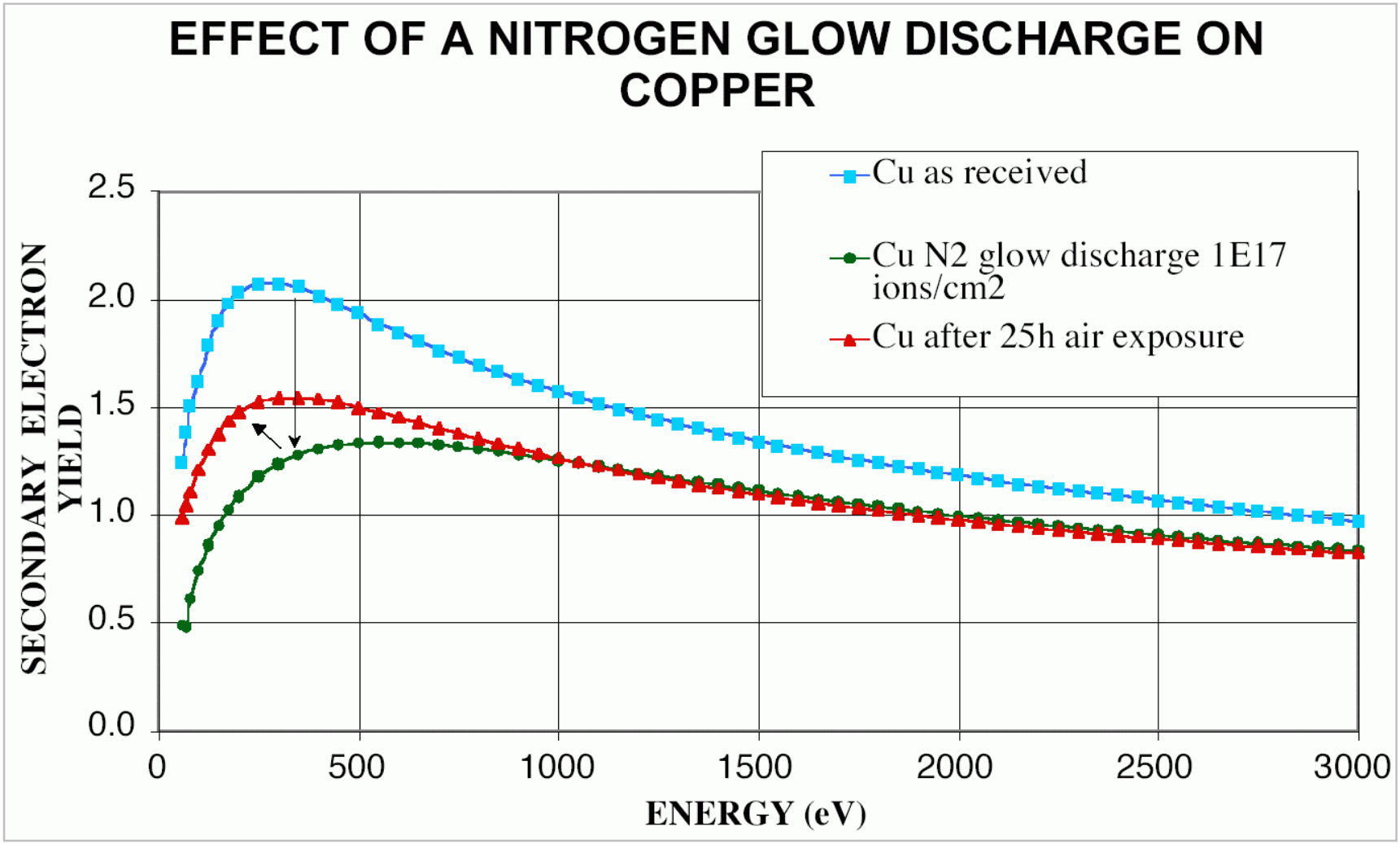
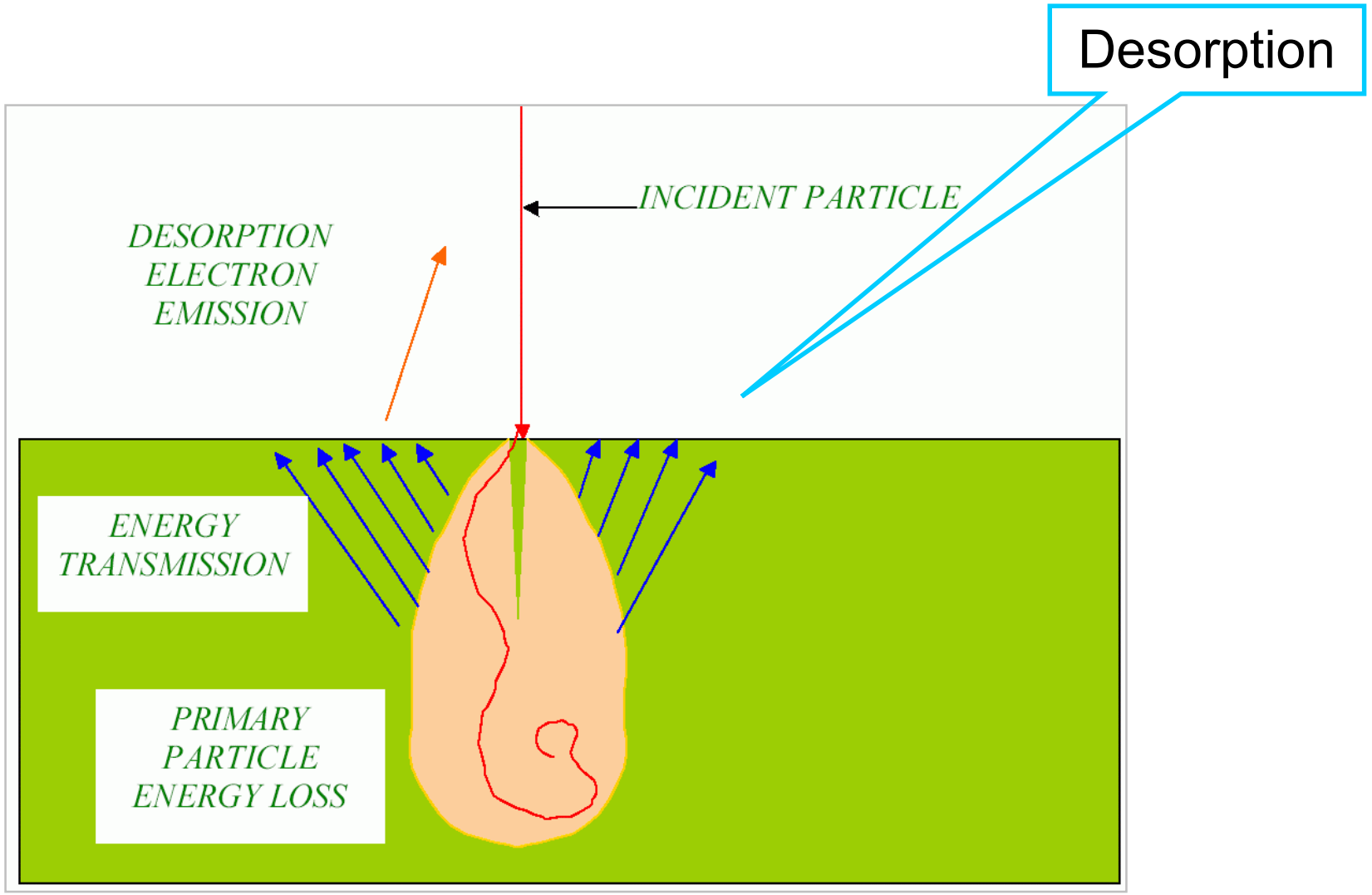
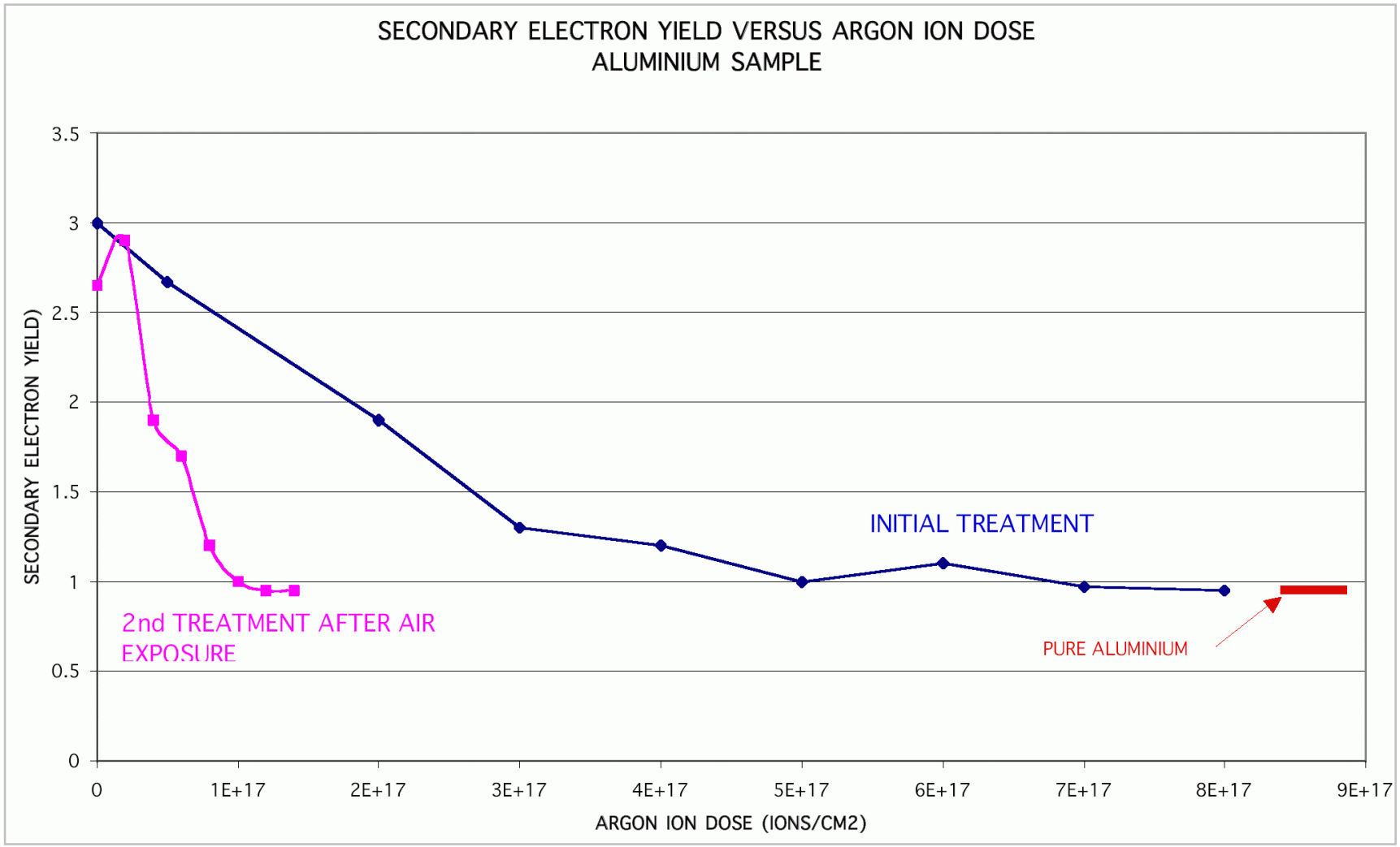
Secondary Emission Yield (6)



Conditioning (1)



Conditioning (2)



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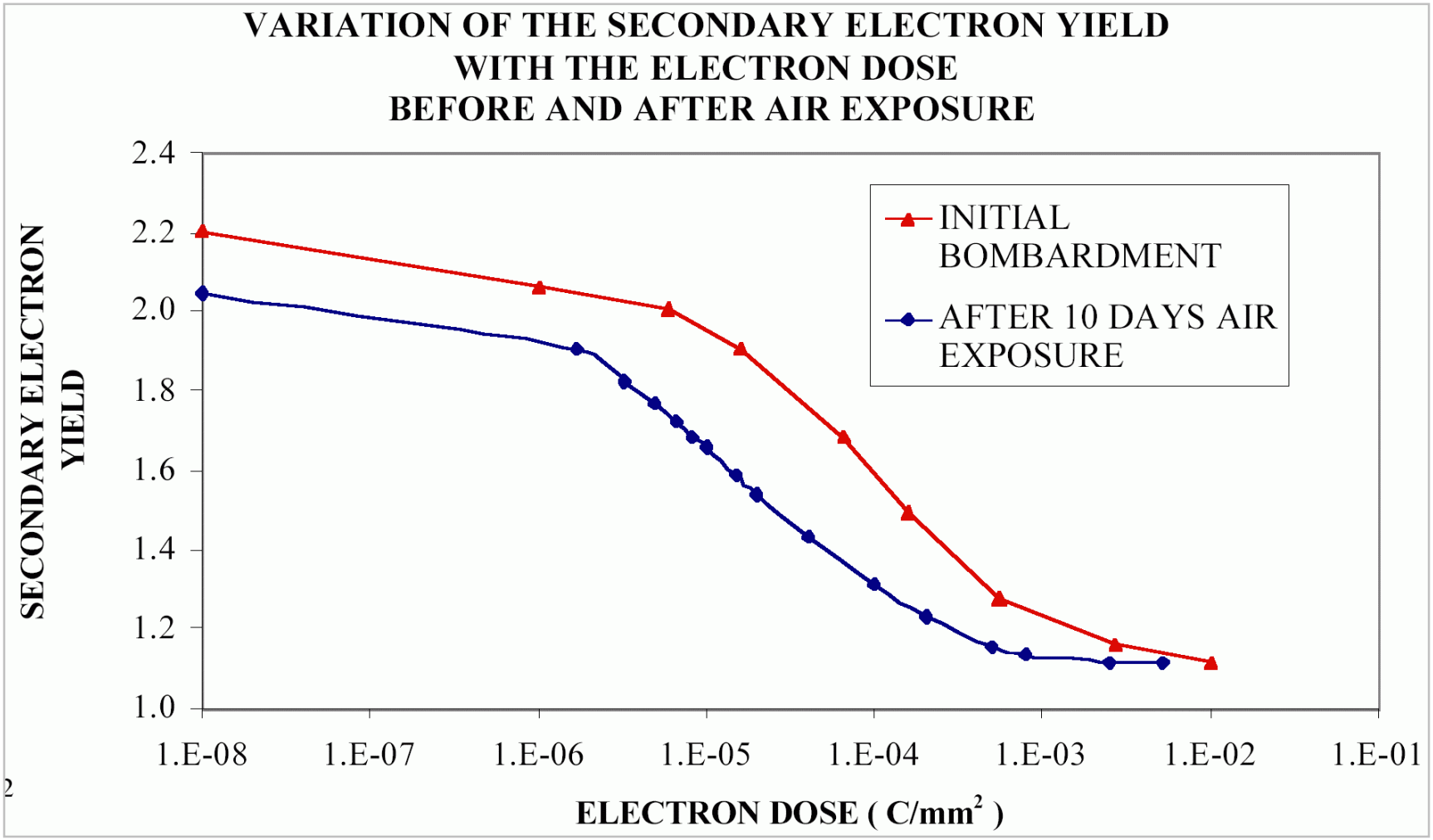
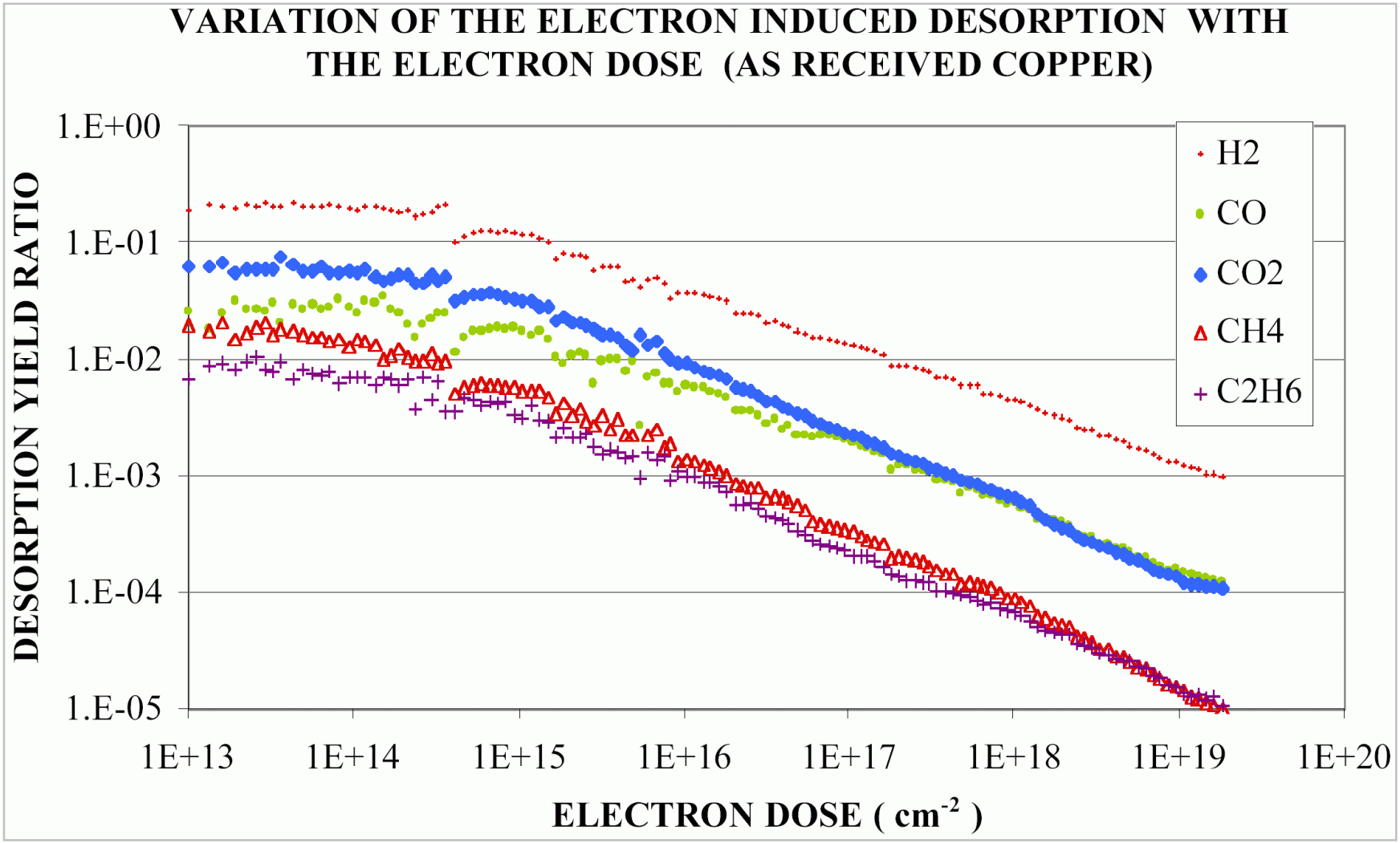
Conditioning (3)



Conditioning (4)



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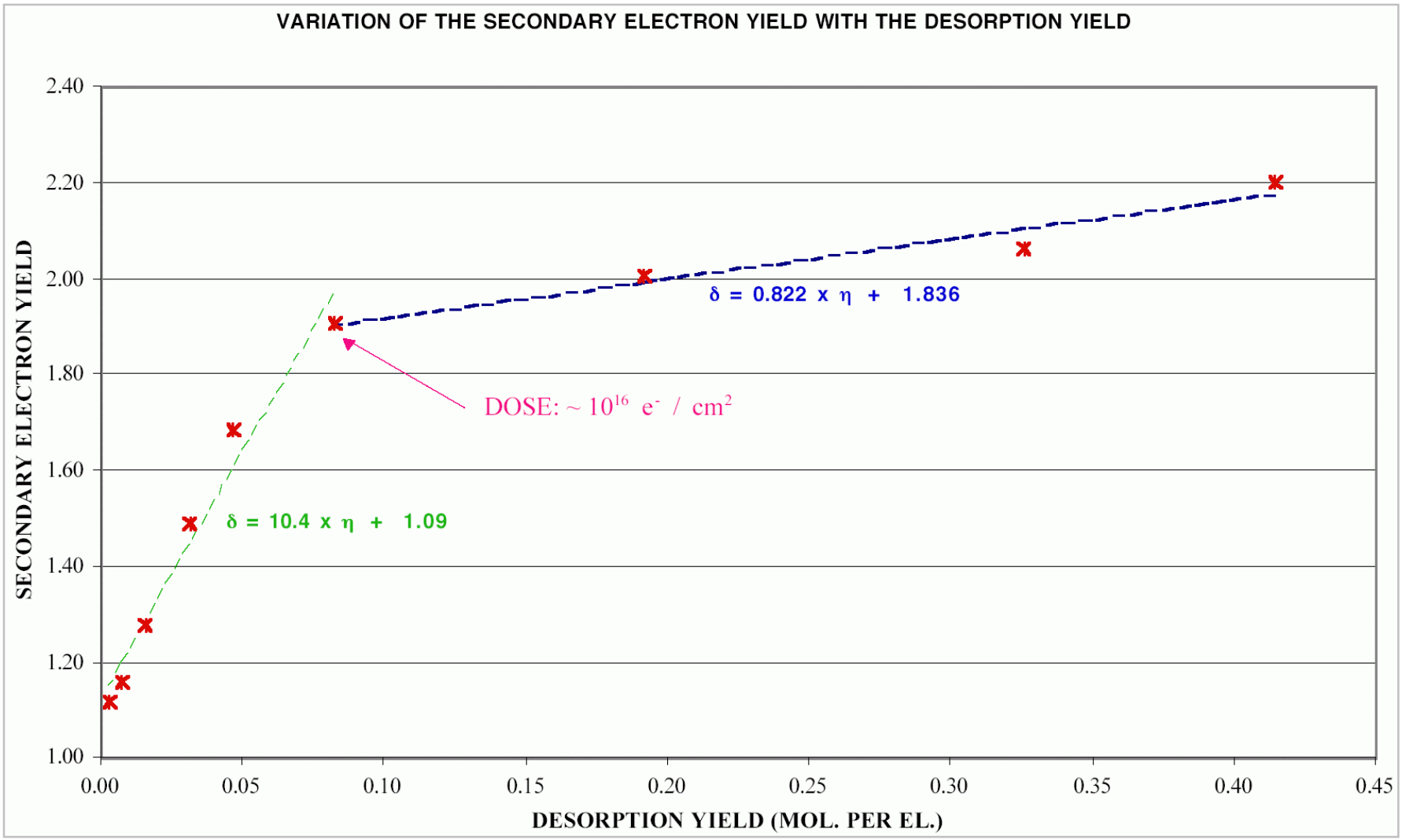
Conditioning (5)



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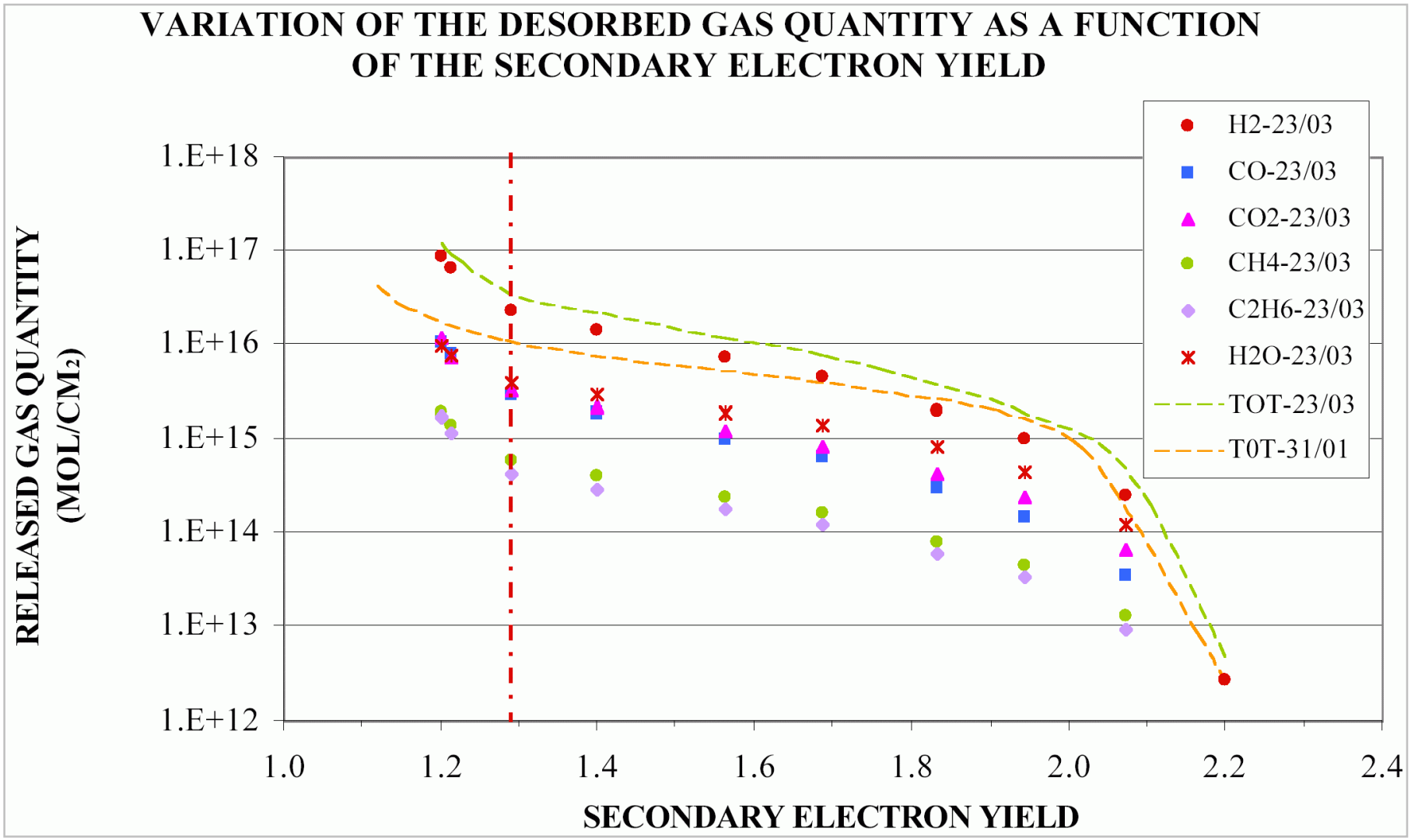
Conditioning (6)



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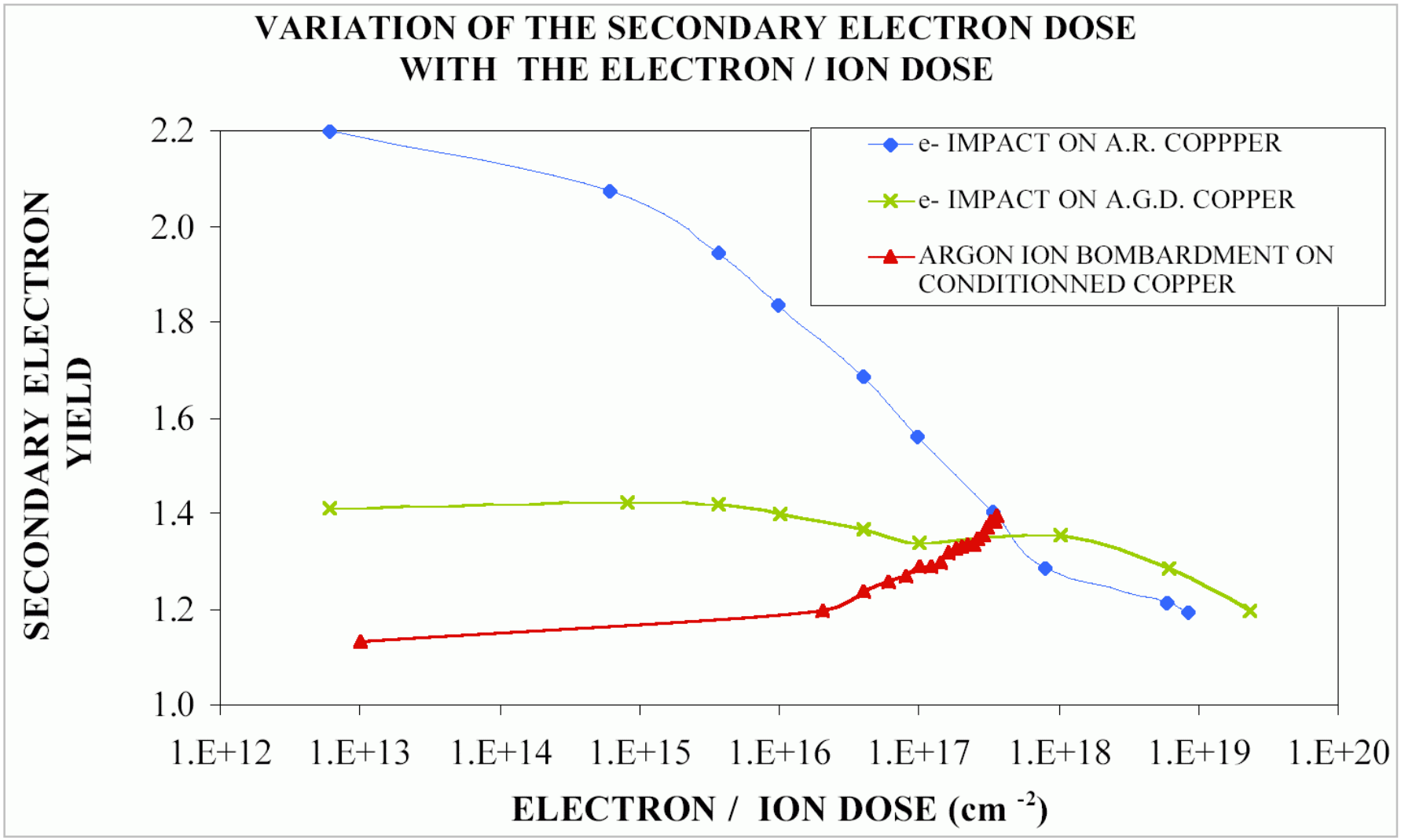
Conditioning (7)



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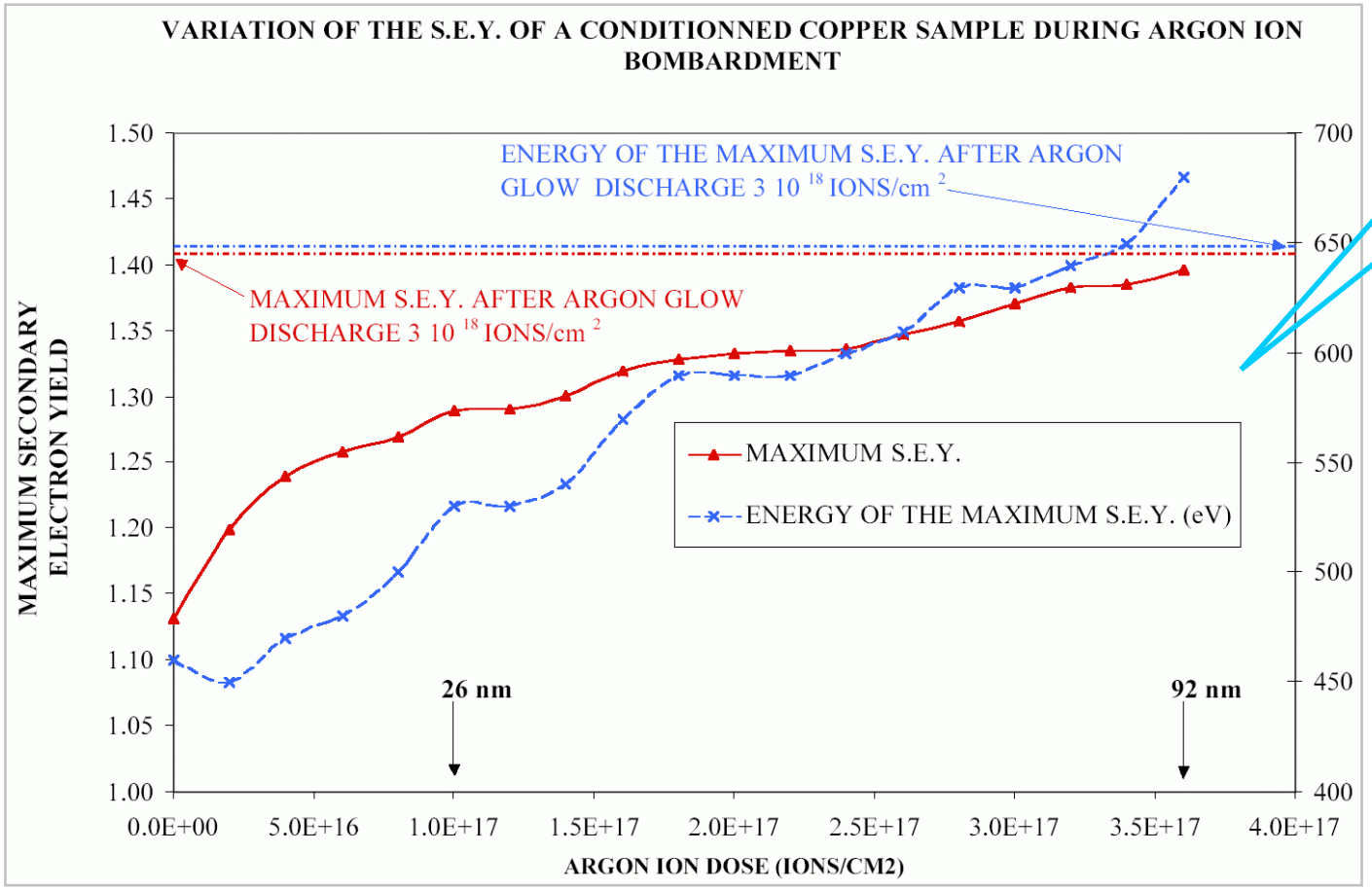
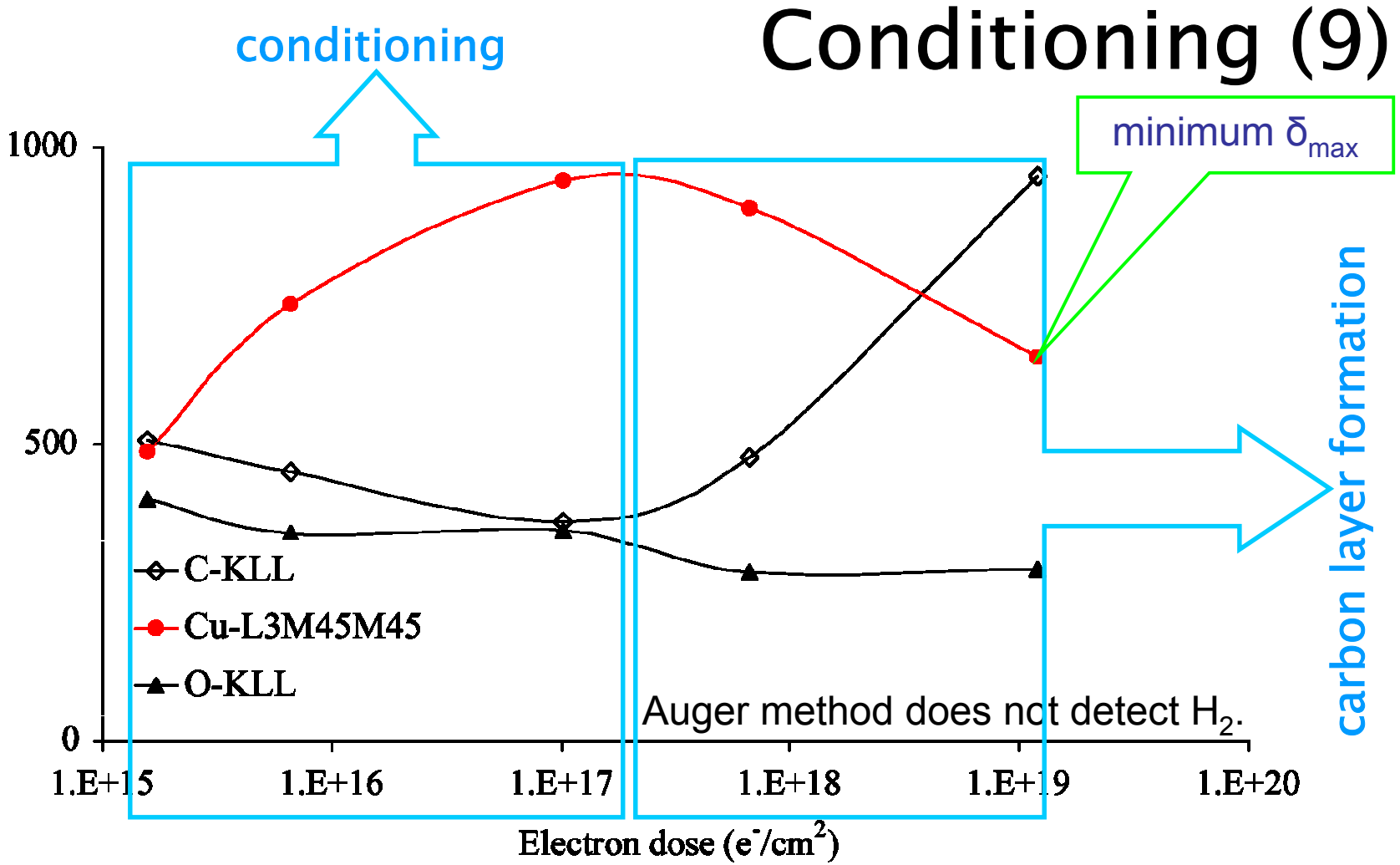


The cleanest surface has not the lowest secondary electron tield

Conditioning (9)



Carbon (C-KLL), oxygen (O-KLL) and copper (Cu, L3M45M45) Auger peak intensity on chemically cleaned copper as a function of the electron dose.

3. Summary

1. The Secondary Electron Emission is strongly surface dependant. It is more determined by surface preparation then by the base material itself.
2. „Wonder layers“ need to be produced in-situ or baked out to be fully efficient.
3. Conditioning is based on the decrease of Secondary Electron Yield with e- dose: usual condensed gases have little effect on the secondary electron yield, exception : noble gases at thick coverages.
4. Desorption and conditioning: parallel phenomena: gas flux variation is a good indicator of the conditioning process. Desorbed gas composition changes with the dose: CO_2 desorption yield decreasing at a faster rate than the one of CO and H_2 (is mostly present).
5. Conditioned surface is very sensitive to the air exposure, but the reconditioning takes less time.